Pollution Sources and Water Quality in the Bistriţa Catchment (Eastern Carpathians)

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The water of the Bistrita River and of its main tributaries has been used to the following ends: drinking water supply, industrial needs, household needs, agriculture, fish culture needs, tourism, hydropower, ballast and river stones extraction, and disposal of industrial wastewater and household graywater/ blackwater. Industry development has led to significant water pollution. The monitoring of water quality within the Bistria catchment is ensured by 17 sections on the river and 7 sections on the reservoirs. The main pollution sources are closely connected with a series of traditional and modern activities. The pollution of waters in the lower basin of the Bistria River is caused, on one hand, by household wastewater from the main human settlements, and on the other, by the disposal of wastewater from the main industrial companies. In the past few years, most economic operators have begun updating the technology of their equipment in order to reduce the polluting characteristics of wastewater. There are ongoing investment programme for constituting or modernizing centralized sewage systems and for wastewater treatment plants. This study comprises the outcomes of pinpointing and analyzing the main pollution sources within the Bistria basin, which influence significantly the quality of water. The water quality bulletins within several points of the basin have been analyzed for this purpose.

Keywords: catchment, pollution sources, wastewater treatment plants, water body, water pollution,

Consumption society requires studying the quality of river and lake waters. The industrialization of the Bistria catchment began in the 60s. Industry development has also led to increasing pollution of the Bistrita River water and of its tributaries. Water pollution is the phenomenon through which the physical, chemical, and biological qualities of water are altered, both directly and indirectly, naturally or through human intervention. Water becomes unsuitable and it is impossible to restore its properties [1-8]. Pollutants are the substances that alter the chemical composition of water. In this case, the consumption of this water by people, animals, plants, etc, may have negative effects. Water comprising pollutants is also called wastewater.

Within the Bistria catchment, situated in the Eastern Carpathians, there are several pollution sources: *natural sources of permanent pollution*, represented by rocks (seen as aquifer, because water washes them); soil (entailed by the erosion process); aquatic vegetation, etc; *natural sources of non-permanent pollution,* represented by meteoric water (not purified in the atmosphere and at the level of the ground); *artificial sources of permanent pollution,* represented by wastewater from household, public, industrial, agrozootechnical, sanitation, etc activities; *artificial sources of accidental pollution,* due to accidents such as untreated wastewater spills, pipes with pollutant substances breaking, etc [1, 9-13].

The main pollution sources within the catchment of the Bistria River are located along the entire Bistria Valley and along the river tributaries. The most important of them are located in the urban areas or around them: Vatra Dornei, Bicaz, Piatra Neamt, Săvinesti-Roznov, Buhusi, and Bacău. One of the most harmful categories of pollution is pollutant loading of industrial wastewater. Water treatment is compulsory, from at least two perspectives: first, because harmful substances spilled in the tributaries produce superficial water pollution; hence, superficial water can no longer be considered a drinking water source; aquatic fauna and flora become contaminated. Secondly, if water is contaminated, it can no longer be used for irrigations, either, because pollutants accumulate in the soil, then they are absorbed by plants, which are subsequently fed to livestock. Therefore, they get into the milk or into meat-based products; ultimately, people consume all these products [14-16].

For preventing and combating water pollution, it is compulsory to be well informed on the nature of polluting substances and on their quantity. Water treatment is usually performed in special water treatment plants; most of them do not work at full capacity, however. When we speak of pollution, the most serious disturbances of the hydrological regime are produced by high water waves following heavy rains, snow melting or both, because they lead to the dispersion of pollutants and to the contamination of water,

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soil, etc [2-3, 17-30]. This study seeks to determine the quality of water within the Bistrita catchment and to establish under which circumstances water can be used in various fields of activity.

Regional setting

The Bistrita River springs from the northern slope of the Rodna Mountains, from an absolute altitude of 1,930 m, and it empties into the Siret River, 9 km south from Bacău, at an altitude of 138 m. The Bistrita catchment drains a surface of 7,039 km¸, because it is one of the most important tributaries of the Siret River (fig. 1). From a geographic perspective, it divides into two sectors: mountainous, from the sources to Piatra Neamt, with accentuated slope, woody vegetation, mountainous, with abundant precipitations and relatively high discharges; sub-Carpathian, with low slopes, woody vegetation replaced by grasslands, and a climate with extreme variations. The main tributaries of the Bistrita River are as follows: Dorna, Neagra Sarului, Neagra Brosteni, Bistricioara, Bicaz, and Tarcău on the right, as well as Cracău on the left.

From a geologic perspective, the catchment of the Bistrita River pertains – almost entirely – (up to Racova) to the geosyncline of Eastern Carpathians, which comprises many types of hard rocks. The Bistrita Valley takes the shape of narrow sections (Cârnu Bicaz region) and wider sections (very wide in the Dornelor depression; in the Hangu region; in the Roznov Piatra Neamt depression) determined by rock resistance. Because of the geologic structure and of river runoff velocity (rock dissolution and erosion), water contains a significant amount of suspensions, which influence its quality negatively. This aspect was improved by the construction of the Izvoru Muntelui reservoir, which plays the role of tank.

In the upper sector of Bistrita, in the winter, when the *zăpor* occurs, there are floods that decrease the quality of water, because of the increased amount of alluvia [29, 31]. The water of the Bistrita River has been used for the following activities: drinking and industrial water supplying, in both an organized and a non-organized setting; ensuring power source (water mills in the upper sector, hydroelectric power plants in the lower sector); recreational objective, first because of the picturesque landscape of touristic interest, and second because of the famed resorts – Vatra Dornei, Borsec, Tulghes, Lacu Rosu (Red Lake); transportation means (wood – rafting); irrigations and gardening – on the lower stream; satisfying household needs (watering, washing, bathing, etc); means of industrial wastewater and household graywater/ blackwater disposal, etc. The main pollution points within the catchment of the Bistria River are as follows: Vatra Dornei, Bicaz, Piatra Neamt, Buhusi, and Bacău.

Experimental part

Materials and methods

In the catchment of the Bistrita River, the quality of water, on both the main stream and a series of tributaries, has been monitored since the 60s, at the following hydrometric stations: for the Bistrita River – the hydrometric stations of Dorna Giumalău, Dorna Arini, and Cotârgasi; for the Cârlibaba River – the hydrometric station of Cârlibaba; for the Dorna River – the hydrometric station of Dorna Cândreni; for the Neagra River – the hydrometric station of Brosteni; for the Bicaz River – the hydrometric station of Bicaz Chei; for the Cracău River – the hydrometric station of Slobozia. It is worth noting that – in that period – there were no hydrometric stations precisely in the most important points from the perspective of water quality, represented by industrial areas. As a matter of fact, industrial areas are significant pollution sources, which require careful monitoring. Currently, the monitoring of water quality within the Bistrita catchment is ensured by 17 sections on the river and 7 sections on the reservoirs (Izvoru Muntelui, Bâtca Doamnei, Recreational Lake Bacău) [32-34]. Samplings have been taken monthly. The data obtained are related to the Directive 2008/1/EC – IPPC (Integrated pollution prevention and control) [35] (table 1).

Findings and discussions

The bodies of water

The water body of Bistria (sources – confluence with Neagra) is assessed through three control sections: Cârlibaba (Bistrita River), Argestru (Bistrita River), and Dorna Candreni (Dorna River). Its characteristics are as follows: mean altitude of 1,230 m; rocky substrate, comprising stones and rocks; windy stream; mean riverbed width of 11 m; mean runoff slope value of 20‰. The ecological status of this water body is good (G), but its chemical status is bad (P), due to the dissolved mercury indicator.

The water body of Neagra (Gura Negrii) is assessed through one control section, at Gura Negrii, on the Neagra River. Its characteristics are as follows: mean altitude of 1,255 m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 9m; mean runoff slope value of 28‰. The ecological status of this water body is moderate (M) because of the phytobenthos biological element, while the biological status is good.

The water body of Bistrita (confluence with Neagra – Izvoru Muntelui reservoir) is assessed through two control sections: Barnar and Frumosu. Its characteristics are as follows: mean altitude of 1,181 m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 15m; mean runoff slope value of 10‰. The ecological status of this water body is good (G), and the chemical status is good.

The water body of Bârnărel (Crucea) is assessed through one control section, at Bârnărel (Crucea). Its characteristics are as follows: mean altitude of 850 m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 20 m; mean runoff slope value of 8‰. The ecological status of this water body is good, but the chemical status is bad due to chloroform and dissolved mercury indicators.

The water body of Bistricioara (Bistricioara, Capu Corbului) is assessed through one control section, at Bistricioara (Bistricioara). Its characteristics are as follows: mean altitude of 1,066 m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 6 m; mean runoff slope value of 14‰. The ecological status of this water body and the chemical status are good.

The water body of Putna (Tulghes) is assessed through one control section, at Putna (Tulghes). Its characteristics are as follows: mean altitude of 1,067 m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 3m; mean runoff slope value of 33‰. The ecological status of this water body and the chemical status are good.

The water body of *Bicaz (Bicaz Chei)* is assessed through one control section, at Bicaz (Bicaz Chei). Its characteristics are as follows: mean altitude of 1167 m; rocky substrate, comprising gravels and rocks; windy stream; mean riverbed width of 3 m; mean runoff slope value of 41‰. The ecological status of this water body and the chemical status are good.

Nr.	Quality indicator	U/M	Quality class				
			I	II	III	IV	V
C.1. Thermal regime and acidifying							
1	***Temperature***	°C	No norms				
2	***pH***		6.5 – 8.5				
C.2. Oxygen regime							
1	***Dissolved oxygen***	mg O_2/L	9	7	5	4	<4
2	***Dissolved oxygen saturation***						
	Epilimnion (stratified layers of water)	%	90-110	70-90	50-70	30-50	<30
	Hypolimnion (stratified layers of water)	%	90-70	70-50	50-30	30-10	<10
	Non-stratified layers of water	%	90-70	70-50	50-30	30-10	<10
3	***CBO_5***	mg O_2/L	3	5	7	20	>20
4	***CCO-Mn***	mg O_2/L	5	10	20	50	>50
5	***CCO-Cr***	mg O_2/L	10	25	50	125	>125
C.3. Nutrients							
1	***Ammonium*** ($N\text{-}NH_4^+$)	mg N/L	0.4	0.8	1,2	3.2	>3.2
2	***Nitrites*** ($N\text{-}NO_2^-$)	mg N/L	0.01	0.03	0.06	0.3	>0.3
3	***Nitrates*** ($N\text{-}NO_3^-$)	mg N/L	1	3	5,6	11,2	>11,2
4	***Total nitrogen*** (N)	mg N/L	1.5	7	12	16	>16
5	***Soluble orthophosphates*** ($P\text{-}PO_4^{3-}$)	mg P/L	0.1	0.2	0.4	0.19	>0.19
6	***Total phosphorus*** (P)	mg P/L	0.015	0.04	0.075	1.2	>1.2
9	***Chlorophyll*** "a"	µg/L	25	50	100	250	>250
C.4. Salinity							
1	***Conductivity***	µS/cm					
2	***Filterable residue dried*** at 105°C	mg/L	500	750	1000	1300	>1300
3	***Chlorides*** (Cl^-)	mg/L	25	50	250	300	>300
4	***Sulphates*** (SO_4^{2+})	mg/L	60	120	250	300	>300
5	***Calcium*** (Ca^{2+})	mg/L	50	100	200	300	>300
6	***Magnesium*** (Mg^{2+})	mg/L	12	50	100	200	>200
7	***Sodium*** (Na^+)	mg/L	25	50	100	200	>200
C.5. Specific toxic pollutants of natural origin							
1	***Total chrome*** ($Cr^{3+} + Cr^{6+}$)	µg/L	25	50	100	250	>250
2	***Copper*** (Cu^{2+})	µg/L	20	30	50	100	>100
3	***Zinc*** (Zn^{2+})	µg/L	100	200	500	1000	>1000
4	***Arsenic*** (As^{3+})	µg/L	10	20	50	100	>100
10	***Barium*** (Ba^{2+})	mg/L	0.05	0.1	0.5	1	>1
5	***Selenium*** (Se^{4+})	µg/L	1	2	5	10	>10
6	***Cobalt*** ($Co^{\cdot\cdot}$)	µg/L	10	20	50	100	>100
7	***Plumb*** $(Pb)^6$	µg/L	5	10	25	50	>50
8	***Cadmium*** (Cd)	µg/L	0.5	1	2	5	>5
8	***Total iron*** ($Fe^{2+} + Fe^{3+}$)	mg/L	0.3	0.5	1.0	2	>2
9	***Mercury*** (Hg)	µg/L	0.1	0.3	0.5	1	>1
9	***Total manganese*** ($Mn^{2+} + Mn^{7+}$)	mg/L	0.05	0.1	0.3	1	>1
10	***Nickel*** (Ni)	µg//L	10	25	50	100	>100
C.6. Other relevant chemical indicators							
1	***Total phenols*** (phenol index)	µg/L	1	5	20	50	>50
2	***Anionic-active detergents***	µg/L	100	200	300	500	>500
3	***AOX***	µg/L	10	50	100	250	>250

Table 1
ELEMENTS AND CHEMICAL AND PHYSICO-CHEMICAL STANDARDS OF QUALITY IN THE WATER

The water body of *Doamna (Doamna)* is assessed through one control section, at Doamna (upstream from the village of Doamna). Its characteristics are as follows: mean altitude of 583m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 2m; mean runoff slope value of 40‰. The ecological status of this water body and the chemical status are good.

The water body of *Bistrita (Izvoru Muntelui reservoir – Pângărai reservoir)* is assessed through one control section, at Bistrita (Straja). Its characteristics are as follows: mean altitude of 1,089m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 15m; mean runoff slope value of 7‰. The ecological status of this water body and the chemical status are good.

The water body of *Bistria (downstream from Bâtca Doamnei reservoir – Racova reservoir)* is assessed through four control sections: Piatra Neamt, Roznov, Zănesti, and Frunzeni. Its characteristics are as follows: mean altitude of 1,034m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 18m; mean runoff slope value of 6‰. The ecological status of this water body and the chemical status are good.

The water body of *Cuejdiu (Piatra Neamt)* is assessed through one control section, at Cuejdiu (Piatra Neamt). Its characteristics are as follows: mean altitude of 680m; substrate comprising blocks and gravels; windy stream; mean riverbed width of 4 m; mean runoff slope value of 27‰. The ecological status of this water body and the chemical status are good. The control and assessment of ecological potential and of chemical status also concerns the water of reservoirs: Izvoru Muntelui (in three sections), Bâtca Doamnei (in three sections) and Recreation Lake Bacău (one section).

The water body of *Izvoru Muntelui* is the largest water body within the Eastern Carpathians. It is situated at an altitude of 513m; it covers a surface of 31 km^2, and it is located on top of a silica substrate. The mean depth of the lake, in the median area, is 36.67 m. The main usages of this lake are as follows: mitigation of high water waves on the Bistrita River; power production; fish culture; recreation. It is monitored through three sections: end – middle of lake; middle of lake; dam. Currently, the water body of Izvoru Muntelui reservoir has shown good ecological potential and chemical status.

The water body of *Bâtca Doamnei* Lake is situated at an altitude of 324.5m, it covers 2.35 km^2, and it is located on top of a silica substrate. The mean depth, in the median area, is 8.1m. The main usages of this lake are as follows: power production; drinking water supply. It is monitored through three sections: middle of lake; dam; water intake. Currently, the water body of the Bâtca Doamnei Lake has shown a good ecological potential. Chemical values do not range within normal quality standards.

The water body of *Recreational Lake Bacău* is situated at an altitude of 155.3m, it covers 0.5 km^2, and it is located on top of a silica substrate. The mean depth, in the median area, is 2m. The main usages of this lake are as follows: industrial water supply; recreation; flood mitigation. It is monitored through one section: middle of lake. Currently, the water body of the Recreational Lake Bacău has shown a good ecological potential.

The sampling sections are situated downstream from the important confluences of from big localities (that represent the main pollution sources). Water samplings were taken from the surface, using 3-litre containers (plastic bottles). The frequency of samplings was established by the Department of Control-Protection and Water quality, by various criteria, as follows: operational (O); investigation (I); surveillance (S); potabilization (P); monitoring programme for vulnerable zones (ZV); the programme of reference (R); best available zone (CBSD); inter-calibration (IC); impact of hydrogeological alterations on waters (CAPM). The equipment used belongs to the Siret River Basin Water Administration and it meets the European standards (Romanescu, Cojoc 2014). For assessing the ecological and chemical status of the surface water bodies, European norms of quality have been used, divided into five quality statuses: high (first quality), good (second quality); moderate (third quality); poor (forth quality); bad (fifth quality) [32]. For this paper, we used the results of the analyses conducted in the laboratory within the Siret River Basin Water Administration, with social address in Bacău.

Water use

Water use is highly diverse within the Bistrita catchment because a wide range of activities are recorded in the area and because of the landforms crossed by the river, which lead to a predominance of a certain type of water use. After analyzing the categories and their distribution pattern in the Bistrita catchment, a series of particularities specific to each water use became obvious. The water of the Bistrita River and of its tributaries has had important usages, such as:

Use in drinking water supply. The population in the area is the main actor, but there is no organized setting. In an organized setting, drinking water supply is done by capturing sources, through wells placed in major riverbed or in the floodplain, or by centralized water supply systems;

Use of water for industrial needs is significantly more developed compared to other catchments, because there are numerous industrial centres using water from the Bistrita River or its tributaries. The first water supply is that of Iacobeni, which captures a discharge of 96 L/s, used for flotation of manganese. At this location, Bistria receives wastewater rich in mineral suspensions. Other industrial water supplies that lead to a decrease in water quality are those of forestry companies in Vatra Dornei, which capture a discharge of circa 31L/s for washing logs, cooling off various engines, etc. The depositions of saw dust and wood dust in the riverbed lead to blockages and to the pollution of water during high waters.

An important point of high industrial water consumption is the village centre of Tasca, which gets industrial water from the Bicaz River for the cement factory. In the city of Piatra Neamt, water is used industrially by the paper and cardboard factory Piatra Neamt, which captures the water of the Bistrita River. Another centre – on the Bistrita Valley – where water is used industrially is Săvinesti. The two units from Savinesti capture a discharge of about 3,000 L/s from the discharge channel of UHE Roznov I and Roznov II.

In the town of Buhusi, SC STOFE BUHUSI SA uses the water. It the past few years, it has stopped using large amounts of water because the company downsized its activity. Downstream, there are several water sampling sources: SC COVIRED SRL – valley mouth; Humanitarian Foundation Dr. Luca – Podis; "Lumina" Association Comănesti – working point of Luncani; city of Bacău.

-*Use of water for household needs.* The waters of the Bistrita River and of its tributaries have been predominantly used for clothes washing, bathing, cattle watering, etc. After the constitution of industrial centres and before wastewater treatment plants, this type of use was limited because the Bistrita River – due to wastewater spills – was not suitable for household use.

-*Use of water for agriculture.* This type of use pertains to the lower course of Bistrita, on the Cracău and Bistri rivers, after the confluence with Cracăul. From this point on, we encounter the pre-mountainous zone, where the valley is wider.

-*Use of water for fish culture needs.* On the Bistrita, the number of fish culture units has increased; the most important of them are situated on the basin reservoirs and on a series of ponds and stews.

-*Use of Bistria valley and of the tributaries for tourism.* The Bistrita catchment is one of the most attractive tourist regions din Romania. From Iacobeni and Vatra Dornei, we encounter balneary and climatic resorts with natural springs, tourist and balneary centres with numerous visitors throughout the entire year: Borsec, Tulghes, Bicaz, Lacu Rosu, Bicaz-Chei, Tarcău, and Piatra Neamt. The tourist interest for this river has increased since the construction of the Izvoru Muntelui-Bicaz reservoir. Another side of this use is the particular fish culture fauna, which attracts numerous sporting fishermen or kayakers.

-*Use as energetic source.* The waters of the Bistrita River have a wide variety of uses in the energetic field, compared to other Siret tributaries or to other Romanian rivers.

-*Use of the riverbed for ballast and river stones extraction.* Locals have been extracting ballast all along the Bistrita River. Except for the mountainous section, numerous depositions of gravels and rocks have been exploited for extracting ballast: Piatra Neam-Săvinesti (circa 800 m long, 50 m wide), Buhusi-Racova (circa 2700 m long, 140 m wide), Bacău-Săucesti (300 m long, 100 m wide).

-*Use of water as means of industrial wastewater and household graywater/blackwater disposal.* This is one of the most important and acute uses of the Bistrita River water.

Pollution sources

The waters streams included in the catchment of the Bistrita River have been treated in a non-organized setting, by various riparian localities or the big cities, but also in an organized setting: industrial units have been disposing of the wastewater in the water streams following an organized and continuous pattern (fig. 1).

Non-organized wastewater disposal does not influence pollution significantly. Wastewater disposal from the great industrial units or from urban centres influences to a great extent the pollution phenomenon. These influences are apparent on all important tributaries, depending on the number and size of industrial units. The first point where polluted water was pinpointed is Iacobeni working point, etc, belonging to the flotation of manganese, where Bistrita receives wastewater rich in mineral suspensions. Another such point is the town of Vatra Dornei, where, beside the sewage system, a series of company also dispose of wastewater in the river (companies are located both in

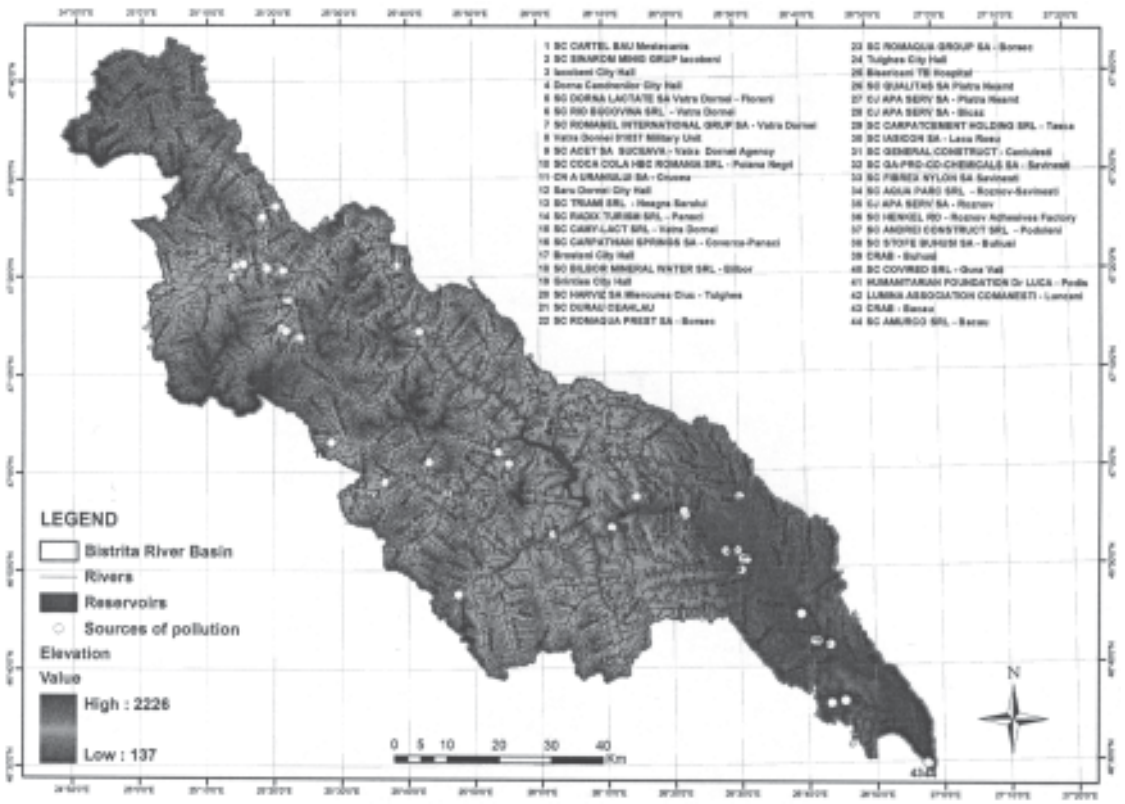

Fig. 1. Pollution sources within the Bistrita catchment

Vatra Dornei and in the surrounding localities.The balneary and climatic resorts (organic and therapeutic mud contamination); like Mestecănis mining perimeter;and – Poiana Negri industrial working point (table 2).

A significant role in the decrease of water quality is played by wood processing companies. They deposit the saw dust and wood dust in the riverbed. When waters rise, this dust is set in motion: it blocks riverbeds and it pollutes the water with suspensions or bran. The most polluting points are the urban centres of Piatra Neamt, Săvinesti, Roznov, Costisa, Buhusi, Bacău, etc. Beside these industrial centres, a great role in river pollution is played by the lumber mills functioning along the valley and by a series of hospitals and sanatoriums, as follows: balneary and climatic resort of Borsec; psychiatric hospital of Tulghes; Pneumophthisiology hospital of Bisericani, etc.

The great and varied number of pollution sources that dispose of their wastewater in the Bistrita River influence negatively several water uses. Because waters set in motion the dust from wood processing companies and the dust deposited on river banks, it has contributed to the drastic reduction of piscicle fauna. Beside the non-organized and chaotic water pollution produced by riparian localities, the river has also been polluted in an organized setting. In the catchment of the Bistrita River, 44 pollution sources were pinpointed (table 2, 3).

After analyzing the pollution sources (tables 2, 3, 4), we found threshold-exceeding values in 25 of the 44 pollution sources (table 5) (ACET Suceava – Vatra Dornei agency; CRAB – Regional centre of the Bacău County – Buhusi section; Dorna Candrenilor City hall; Saru Dornei City hall; C. J. APA SERV S.A. – Wastewater treatment plant Bicaz; Grintes village; Brosteni City hall; ROMAQUA PREST S.A. Borsec; C.J. APA SERV S.A. – wastewater treatment plant Roznov; CN Uraniu S.A. Crucea; S.C. Dorna Lactate S.A.; Vatra Dornei – UHT Floreni section; ROMANEL

No.	Equivalent no. of inhabitants	Pollution sources urbane
1	>100,000	*CRAB – Regional centre of the Bacău city
2		*C.J. APA SERV S.A. – Wastewater treatment plant Piatra Neamț
3	10,000 – 100,000	**ACET Suceava –Vatra Dornei agency
4		**CRAB – Regional centre of Bacău County – Buhuşi section
5	2,000 – 10,000	*Dorna Candrenilor City hall
6		*Iacobeni City hall
7		*Şaru Dornei City hall
8		*C. J. APA SERV S.A. – Wastewater treatment plant Bicaz
9		*Grinţieş Village
10		*Tulghe village – wastewater treatment plant
11		**Broşteni City hall
12		**ROMAQUA PREST S.A. Borsec
13		***C.J. APA SERV S.A. – wastewater treatment plant Roznov

*it functions lawfully; **it functions outside the law; ***no station.

Table 2
URBAN POLLUTION SOURCES

No.	Pollution sources	
1	IPPC	S.C. CARPAT CEMENT HOLDING S.A. Bucharest– working point Tasca
2		S.C. GA-PRO-CO-CHEMICALS S.R.L. Săvineşti
3		S.C. AMURCO S.R.L. Bacău
4	*non-* IPPC	S.C. CARPATHIAN SPRINGS S.A. Coverca – Panaci
5		S.C. CARTEL BAU S.A. Mestecăniş
6		C.N. A URANIULUI S.A. Crucea
7		S.C. COCA-COCA HBC România SRL Dorna – working point Poiana Negri
8		S.C. DORNA LACTATE S.A., Vatra Dornei – UHT Floreni section
9		S.C. RIO BUCOVINA SRL – working point Vatra Dornei
10		S.C. ROMANEL INTERNAŢIONAL GRUP S.A. Vatra Dornei
11		S.C. SINAROM MINING GRUP SRL Iacobeni
12		S.C. FIBREX NYLON S.A. Săvineşti
13		S.C. STOFE BUHUŞI S.A.

Table 3
INDUSTRIAL POLLUTION SOURCES

***Directive 2008/1/EC - IPPC** on integrated pollution prevention and control has the purpose of protecting effectively the environment as a whole, by implementing prevention measures or measures of reducing emissions in the atmosphere, the water, and the soil (http://www.anpm.ro/).

No.	The pollution source
1	SC RADIX TURISM SRL – Panaci
2	SC CAMY-LACT SRL – Vatra Dornei
3	SC TRIAMI SRL – Neagra Şarului
4	UM Vatra Dornei 01037
5	SC BILBOR MINERAL WATER SRL – Bilbor
6	SC IASICON SA – Red Lake
7	SC QUALITASCOM SRL
8	SC ROMAQUA GROUP SA – Borsec
9	SC ANDREI CONSTRUCT SRL – Costişa
10	SC AQUA PARC SRL Roznov – Savineşti
11	SC DURAU CEAHLĂU
12	SC GENERAL CONSTRUCT – Căciuleşti point
13	SC HENKEL RO – Fabrica de adezivi Roznov
14	SPITALUL DE PNEUMOFTIZIOLOGIE – Bisericani
15	ASOCIA□IA LUMINA COMĂNEŞTI – working point Luncani
16	SC COVIRED SRL – sorting station of Gura Văii
17	HUMANITARIAN FOUNDATION DR. LUCA – Podiş Health Centre
18	SC HARVIZ SA Miercurea Ciuc – working point Tulgheş

Table 4
POINTS OF POLLUTION SOURCES

INTERNAIONAL GRUP S.A. Vatra Dornei; SC RADIX TURISM SRL – Panaci; SC TRIAMI SRL – Neagra Sarului; UM Vatra Dornei 01037; SC IASICON SA – Red Lake; SC QUALITASCOM SRL; SC ROMAQUA GROUP SA – Borsec; SC ANDREI CONSTRUCT SRL – Costisa; SC AQUA PARC SRL Roznov – Savinesti; SC DURAU CEAHLĂU; Pneumophthisiology hospital – Bisericani; "LUMINA" ASSOCIATION COMĂNESTI – working point Luncani; Humanitarian Foundation Dr. Luca – Podis Health Centre; SC HARVIZ SA Miercurea Ciuc – working point Tulghes). Mostly ammonium and nitrogen compounds were found to have exceeded accepted values (SC RADIX TURISM SRL; SC TRIAMI SRL; Dorna Candrenilor City hall). Obvious excesses were found in ammonium, CBO5, CCOCr, sulphide, nitrogen/nitrate/nitrite, phosphorous, detergent, and suspension.

CN Uraniu S.A. Crucea and the Pneumophthisiology hospital – Bisericani have exceeded most parameters: matters in suspension; CBO5; CCO Cr; phosphorus; ammonium; sulphurs; nitrogen compounds; synthetic detergents. Excesses in synthetic detergents were found only in four cases.

Situation of wastewater treatment plants

Effluents of wastewater treatment plants maintained the same pollution level as in the past. In this case, S.C. ACET S.A Suceava – Vatra Dornei Agency is a mechanical-biological wastewater treatment plant, situated on the left bank of the Bistrita River, at km 688. It has a capacity of 85 l/s, a discharge mouth and a mean evacuated discharge of 40 L/s. The wastewater treatment plant has 62% productivity.

In the Neamt County, out of the total number of wastewater treatment plants that evacuate wastewater in natural receptors, 7 wastewater treatment plants functioned within normal parameters (S.C. ROMAQUAPREST S.A. Borsec is currently modernizing the technology), while 10 wastewater treatment plants functioned with deficits. The improper functioning of wastewater treatment plants has been pinpointed by poorly treated effluents (that is, by evacuations that exceeded the maximum admitted concentrations).

Wastewater treatment plants that function within normal parameters dispose of wastewater while making sure of meeting the quality requirements of water management authorities. Wastewater treatment plants in the catchment of the Bistrita River that do not function within normal parameters belong to economic agents within the food industry (SC Romaqua Group SA Borsec, etc).

The existing wastewater treatment plants do not evacuate the wastewater effectively, either because of outdated technology, or because of incorrect exploitation. Improper functioning of wastewater treatment plants has led to exceeding values of pollution and to penalties, according to the legislation specific to urban or rural wastewater treatment plants (Bicaz, Piatra Neamt, Roznov, Grinies, and Tulghes).

Indicators	Carlibaba	Argestru	Barnar	Frumosu	Straja	Piatra Neamț	Zărnești	Șerbănești	Frunzeni	Aval Bacău	Roznov
Discharge	7.4	11.7	23.54	38.41	5.79	48.15	47.43	63.04	18.10	5.74	11.85
Water temperature	7.3	7.4	8.0	8.38	8.36	9.44	9.42	10.34	9.97	12.33	8.98
pH	7.8	7.8	7.89	7.82	8.16	10.35	7.88	7.85	8.01	7.76	8.34
Dissolved oxygen	10.7	10.7	10.60	11.10	10.52	10.81	10.88	16.74	9.78	6.52	57.99
CBO5	1.5	1.9	2.07	2.82	2.94	2.57	2.63	3.03	4.64	45.55	12.71
CCO-Mn	3.0	3.8	4.41	4.04	4.92	2.80	3.18	6.02	7.10	82.39	14.84
CCO-Cr	5.5	7.3	8.21	9.75	18.65	7.14	10.39	14.41	14.38	182.99	49.41
Fixed residue	142.1	141.5	153.53	120.88	233.63	154.29	172.79	254.51	267.50	518.64	251.71
Chlorides	12.4	4.9	5.14	6.58	11.24	6.90	11.24	25.11	29.29	64.60	24.83
Sulphates	15.1	22.1	31.31	22.53	29.58	22.62	25.14	56.38	34.77	103.86	34.04
Calcium	31.4	30.9	32.06	29.16	60.02	40.80	41.75	51.50	58.12	79.43	54.94
Magnesium	11.9	11.4	11.29	6.52	10.42	10.15	7.65	14.73	9.83	20.85	9.22
Sodium	3.8	4.6	4.89	5.96	10.80	6.64	8.88	22.59	18.61	49.39	18.98
Ammonium	0.2	0.1	0.14	0.03	0.05	0.03	1.05	0.67	2.70	18.83	0.65
Nitrites	0.00	0.00	0.02	0.02	0.04	0.01	0.08	0.54	0.34	1.02	0.16
Nitrates	1.4	1.7	1.90	2.08	3.10	0.82	3.69	2.61	9.41	4.41	17.55
Cyanides	-	-	-	0.00	0.00	-	0.00	0.71	0.00	0.91	0.00
Phenols	-	2.2	-	0.01	0.00	-	0.00	1.23	0.02	1.65	0.00
Deterg.	-	-	-	0.00	0.00	0.00	0.00	23.87	0.01	82.47	0.02
Oil products	-	-	-	0.00	0.00	-	0.00	0.03	10.27	2.78	30.90
Iron	0.1	0.3	0.35	0.21	0.12	0.10	0.30	0.25	0.17	1.64	0.18
Phosphorus	0.00	0.00	0.04	0.09	0.04	0.02	0.03	0.07	0.09	3.01	0.14
Manganese	0.1	0.4	0.33	0.09	0.04	0.01	0.01	0.03	0.05	-	0.09
Mercury	-	0.00	-	-	-	-	0.00	-	0.00	-	-
Nickel	-	2.1	-	-	-	-	0.00	-	0.00	-	-
Chrome	-	0.3	0.03	1.04	1.72	12.41	0.40	6.95	0.05	-	0.39
Copper	0.4	1.3	1.32	5.31	4.44	7.62	2.87	3.35	1.26	4.82	0.79
Lead	-	3.1	0.06	-	-	-	-	-	0.00	-	-
Zinc	1.0	2.0	2.47	26.76	42.75	10.95	35.63	40.24	3.57	17.39	5.72
Cadmium	-	0.4	-	-	0.00	-	-	-	0.00	-	-
Aluminium	-	-	-	-	-	140.35	-	-	-	-	-
Suspensions	25.1	33.4	41.65	35.03	48.05	8.89	15.48	39.76	67.87	86.83	30.87
HCO3	114.8	124.3	126.93	89.40	189.60	125.05	130.22	179.02	183.79	292.70	172.09
Permanent hardness	2.1	1.9	2.20	1.29	1.57	1.69	1.32	2.86	2.18	4.71	1.65
Temporary hardness	5.0	5.3	5.36	4.45	9.25	5.77	6.21	8.06	8.59	13.12	8.19
Total hardness	7.2	7.2	7.63	5.50	10.73	7.45	7.55	10.66	10.80	16.78	9.83

Table 5
MEAN VALUES OF THE MAIN CHEMICAL INDICATORS WITHIN THE BISTRIA CATCHMENT FOR THE PERIOD 1993-2011

For advanced water treatment and for normal values of effluents, several investments in the area have set the purpose of updating the technology of existing wastewater treatment plants and of constructing new wastewater treatment plants. Urban or rural wastewater treatment plants of Bicaz, Piatra Neamt, and Tulghes have been endowed with modern water treatment equipment, meant to ensure optimal quality parameters and the compliance of the effluent to the limits imposed by regulations into force. The incorrect exploitation of stations led to the emergence of incidents that, in their turn, led to exceeding the maximum allowed concentrations of pollutants in the evacuated water. The wastewater treatment plant of Roznov is inefficient and on the verge of being shut down. According to the project, sewage networks will be extended and a connection will be established with the main collector, thus transporting this section of wastewater to the wastewater treatment plant of Podoleni.

For wastewater treatment, investments were used for modernising the wastewater treatment plant of the Piatra Neamt city. The project unfolded in the period 2006-2010. The modern technologies brought to the wastewater treatment plant including tertiary treatment for nutrient reduction. The EU ensured 68% of the funds, while 32% came from the company CJ Apa Serv SA.

Effluents of the wastewater treatment plant pertaining to the Pneumophthisiology hospital in Bisericani have not been treated properly: excesses were found in suspensions, oxygen-consuming substances (expressed by CBO5 and CCOCr), ammoniacal nitrogen, total nitrogen, and total phosphorus. The existing equipment of the wastewater treatment plant (mechanical treatment, biological filter) cannot ensure proper wastewater treatment. For removing the pathogenic agents from the wastewater, disinfection equipment was installed in 2011 (hypochlorite container). The county Council of Neamt financed the entire project.

Wastewater treatment plants of commercial units and units serving the population – SC Bilbor Mineral Water SRL Pantelimon and SC Durău SA Durău – function within accepted parameters: effluents are properly treated and they ensure the qualitative parameters of wastewater within the limits imposed by water management authorized bodies. SC DURĂU SA Durău has invested in updated the technology of the wastewater treatment plant. 60% of the funds came from the company per se, while 40% from the Environment Fund Administration. The wastewater treatment plant was inaugurated in January 2010. The effluents of wastewater treatment plants belonging to the

companies from Săvinesti and Tasca are properly treated and they range within accepted limits.

After analyzing the amounts of disposed pollutants by economic activities, urban wastewater treatment plants were found to evacuate the highest level of surface pollutants. Food industry companies represent major pollution sources, though the volume of disposed wastewater is significantly smaller than the volume evacuated from the urban/rural/industrial stations. In order to ensure the conditions for the protection of aquatic ecosystems, the stations with a treatment programme approved by the "Romanian Waters" National Administration have invested from improving the quality of effluents of wastewater treatment plants (the purpose is to range within legal limits) and for implementing new treatment solutions.

S.C. GA-PRO-CO. CHEMICALS SA Săvineati has conducted a pre-feasibility study to reduce pollutants specific to wastewater (NH_4,NO_3, Cl, and urea); the purpose is for the effluent of the society to range within legal limits after the execution project. The wastewater treatment plant of the town of Borsec (SC Romaquaprest SA Borsec - wastewater treatment plant operator) comprises only mechanical treatment; there is no biological treatment for reducing organic loading or tertiary treatment for reducing nutrients. The Borsec Local Council has promoted an investment titled Works for rehabilitating and extending the sewage network, and for building wastewater treatment plant with tertiary treatment. They have already finalized the works for rehabilitating and extending the sewage network. As for the wastewater treatment plant, they finalized the building stage and began endowments with various equipment and machines. The company Ga-Pro-Co Chemicals SA has to comply with the Directive 96/61/EC concerning Integrated Pollution Prevention and Control, transposed in the Romanian legislation through GEO 152/2005. For complying with the rules, works for updating the technology and for reducing pollutants characteristic to technological wastewater must be finalized by 2014.

In order to ensure the conditions for protecting aquatic ecosystems, there are several ongoing investment programmes targeting water users (economic agents or U.A.T.), with the purpose of constituting or modernizing centralized sewage systems and wastewater treatment plants for the rural localities of Girov, Dochia, Ceahlău, Grinties, Crăcăoani, Hangu, Dobreni and for the urban localities of Roznov and Buhusi.

There are three wastewater treatment plants with proper functioning within the city of Bacău, as follows: Association of the Carmelite Order in Luncani, SC Amurco SRL Bacău, and SC Covired SRL Gura Vaii. Other three wastewater treatment plants function with deficits: "Lumina" Association Comănesti - Luncani; CRAB regional centre of Bacău County – Buhusi section; SC Stofe SA Buhusi. Wastewater treatment plants functioning with deficits have recorded excessive values of indicators because of outdated equipment, of improper maintenance and exploitation of stations, and lack of treatment capacity.

CRAB Municipal Centre of Bacau has a wastewater treatment plant with a capacity of 1,650 L/s – projected for serving 295,000 inhabitants. The mean evacuated discharge is 676.7 L/s. Waters are disposed of in the Bistrita River. CRAB Regional Centre of Bacau County – Buhusi section serves the locality of Buhusi, comprising a population of 26,200 equivalent inhabitants. Wastewater treatment has been ensured by a wastewater treatment plant comprising mechanical and biological treatment, with a maximum capacity of 110 L/s and a mean evacuated discharge of 21,580 L/s. Wastewater treatment complies with the quality requirements of water management authorities.

Conclusions

The detailed analysis of pollution sources within the catchment of the Bistrita River found that, in the past few years, most economic operators have begun updating the technologies of their equipment, in order to reduce pollutants characteristic to wastewater. Currently, there are several ongoing investment programmes, for constituting or modernizing centralized sewage systems and wastewater treatment plants.

From a qualitative perspective, waters of the Bistrita River are divided into two sectors: the upper stream, where water parameters are high (first quality class) and the middle and lower streams, where water parameters are moderate. The water pollution of the lower basin of the Bistrita River is caused by household wastewater from the main human settlements and by wastewater disposal from the main industrial companies.

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